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UNITED STATES DEPARTMENT OF AGRICULTURE

# BULLETIN No. 1096

WASHINGTON, D. C. ▼ August 12, 1922

# BY-PRODUCTS FROM CRUSHING PEANUTS.

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## PEANUT-CRUSHING INDUSTRY.

The popular idea seems to be that the peanut is marketed chiefly in the roasted form. As a matter of fact, however, these nuts are used principally in making salted peanuts, peanut butter, and confectioners' and bakers' goods, and in the manufacture of oil and meal. The peanut industry was of little commercial prominence until 1870, when it began to grow gradually. By 1900 the quantities of peanuts raised were increasing rapidly, and since 1915, when the crushing of peanuts for oil and meal was undertaken on a commercial scale, the growth of the peanut-crushing industry has been phenomenal. This growth may be attributed to the fact that the peanut can to a large extent take the place of cotton as a cash crop in regions seriously infested with boll weevil. Short cotton crops have placed the planters and oil millers in large cotton-producing areas in an extremely difficult position. The planters suffered from being deprived of a cash crop and the oil millers suffered from having heavy investments in oil mills for which there seemed to be no further use. The utilization of the peanut for making oil and meal gave the planters a new cash crop and enabled the millers to continue their operations.

[1] Acknowledgment is made to G. P. Walton and L. E. Bopst, of the Cattle Food Laboratory, for assistance in the analytical work.

## CRUSHING PEANUTS.

### VARIETIES USED.[2]

The Spanish variety is the one grown principally for the production of oil. The meats of this variety have a higher oil content than those of any other, with the possible exception of the Valencia, or Tennessee red. It has a higher proportion of meats to hulls than any other variety and is adapted to a wider range of soil and climatic conditions.

### PROCESSES.

Most of the crushing of peanuts is done in cottonseed-oil mills, which are well adapted to this work. These mills run for part of the season on cotton seed, when it is available, and for another part of the season on peanuts. Thus a close relationship exists between the cottonseed-oil industry and the peanut-oil industry, although many mills crush peanuts exclusively.

The processes for crushing peanuts in this country are of two distinct types—the hydraulic, which is intermittent, and the expeller, which is continuous.

### HYDRAULIC PROCESS.

From the storehouses to which they are brought by the farmers the peanuts are run through shakers or conveyors having fine sieves, to remove the sand and fine dirt, and then through larger sieves, consisting of perforated plates having holes large enough to permit the peanuts to drop through, thus separating them from the sticks, vines, stones, and larger pieces of trash, which pass out from the tail of the machine.

The peanuts are next taken in screw conveyors to the huller. Sometimes this is an ordinary cottonseed bar huller, or a slight modification of it, consisting of a cylinder the lower part of which is made of sharp-edged steel bars, with revolving sharp-edged bars attached to a frame within. The peanuts are chopped as they pass between the sharp edges, and the meats and hulls pass out through slits between the bars. Most mills, however, use the so-called disk huller. This consists of a cylinder the lower half of which is made of steel bars properly spaced, having inside rough-faced disks, some revolving and others stationary, placed side by side, so that the revolving disks alternate with the stationary disks. Peanuts are fed in at the top, the hulls are rubbed off as they pass between the disks, and the hulls and meats pass out through the slits between the bars below.

The stock is next conveyed to a shaker machine, where the meats are separated from the hulls by means of sieves and an adapter

[2] A complete description of the varieties of peanuts grown in the United States is given in Farmers' Bulletin 751, copies of which may be had on application to the Division of Publications, U. S. Department of Agriculture, Washington, D. C.

attached to the air-suction pipe which sucks the hulls away from the meats. This adapter, which is funnel-shaped and flattened out to a slit about 2 inches wide, extends from one side to the other of the shaker over which the mixture of meats and hulls is passing. In some mills only one adapter is used; in others several adapters are placed side by side. By varying the speed of the fans and making other adjustments, it is possible to separate practically all the hulls from the meats or retain any desired amount. In the past the practice has been to leave 10 or 15 per cent of the hulls in the meats for the purpose of securing a satisfactory extraction. It has been found, however, that this is not necessary for a successful extraction. In fact, the presence of the hulls prevents efficient extraction, for the reason that they soak up oil like a sponge. Most up-to-date mills now remove all hulls possible from the meats before crushing.

After the hulls have been removed the meats pass through rolls, which crush them. In some cases the rolls that are employed in crushing cotton seed are used, but usually they are modified by having some of the smooth rolls replaced by corrugated rolls. The object of crushing is to open the oil cells as much as possible, thus securing a more efficient extraction.

From the rolls the crushed meats go to the cooker, where they are tempered and cooked for the purpose of further breaking up the oil cells.

From the cooker the material goes to the cake formers, where it is made into cakes inclosed in hair cloth. The cakes are then placed in the hydraulic presses and subjected to great pressure, which presses out most of the oil, leaving a cake containing from 6 to 8 per cent of oil. This cake is ground into meal. Usually some of the hulls previously removed are ground back with it, to give meal containing the desired amount of protein.[3] The idea seems to be to produce meal corresponding in protein content to the various grades of cottonseed meal.

### EXPELLER PROCESS.

In the expeller process the peanuts are not subjected to cooking, but are chopped and heated to some extent in a steam-heated conveyor which carries the material to the expeller. Usually the hulls are not removed, so that often the cake contains all the hulls. Some mills, however, shell the peanuts and crush them, thus securing an excellent virgin oil that needs no refining, but is merely filter-pressed. The cake obtained in this way makes a meal having an exceptionally high protein content and is the source of peanut flour.

[3] Hulls are either left in cottonseed meal or are ground back in, to give a cottonseed meal of desired protein content.

### SHELLING PLANTS.

Many mills run shelling plants in which the best nuts are separated to be marketed as shelled peanuts. The seconds are either pressed out separately or run in with the regular stock when the mill is running on stock peanuts in the usual way. The principle of the sheller is the same as that of the disk huller (p. 2), but in addition it has attached to it screens, shakers, and fans, so that the meats come out almost entirely separated from the hulls. The machine is run to make as many of the meats as possible come out whole.

## PRODUCTS OBTAINED FROM CRUSHING PEANUTS.

Some mills make feeds by grinding the peanut cake with peanut hulls, hay, cottonseed meal, cottonseed hulls, etc., with the idea of utilizing the hulls, which have a very low feeding value. It may be possible to use the hulls in this way if the product is not to be shipped very far, but their shipment for any great distance is not economical.

Meals containing from 45 to 50 per cent of protein are produced but seldom placed on the market. Meals containing all the hulls, with a protein content of from 34 to 38 per cent, and meals containing an excess of hulls obtained from shelling plants or some other source are also found. Between these extremes are several grades.

Some mills run almost entirely on seconds, which they buy from shelling plants, and on the germ (known to the trade as the heart) and skins, which they obtain from peanut-butter mills and peanut-confection establishments. A low-grade oil and a low-grade meal are thus obtained. Although peanut skins do not contain much oil originally, those from peanut-butter mills are high in oil, which is tried out from the meats and absorbed by the skins during the roasting. Such skins contain from 20 to 30 per cent of oil. Products obtained by crushing skins, germs, low-grade meats, etc., should not be designated as peanut meal; they should be labeled to show the true character.

Fertilizers are among the valuable products obtained from the crushing of peanuts. Peanut cake, however, is too valuable as a feed to be used directly as a fertilizer. The ideal thing would be to feed all the peanut meal produced to animals, using the resulting manure for fertilizer. Unfortunately, it is not always possible to do this. For business reasons a great deal of peanut meal is sold to the planters, who use it directly for fertilizing purposes. Often it seems advisable for the oil millers to buy the peanuts from the planters, giving them the peanut meal as part payment. The planter brings in a load of peanuts and takes away a load of meal. In this way the working capital of the mill is reduced materially, while the

farmer saves on his transportation of fertilizer. Although, from a broad economic standpoint, it is not good practice to use either cottonseed meal or peanut meal directly as a fertilizer, this practice probably will be continued on account of local conditions.

The unusual value of peanut meal as a feed for animals, which is not generally recognized, has been reported by C. O. Johns and D. Breese Jones,[4] who have brought out the important fact that the proteins in this product are high in lysine.

Osborne and Mendel and other workers have shown that lysine is essential to the growth of animals. Nutrition experiments indicate that the animal organism can not synthesize lysine, which must, therefore, be provided in suitable quantity in the food to insure normal growth. Since the muscle substance of animals contains about 7 per cent of lysine, foods deficient in this essential amino-acid should be supplemented by the addition of other foods which contain a high percentage of lysine. Wheat and corn, both of which contain but little lysine, should therefore prove more efficient diets if supplemented by some food of high lysine content. Peanut meal appears to be well adapted to this purpose. From a nutritive standpoint, it is one of our cheapest foods and seems to possess no objectionable properties. Animals fed on it thrive and increase rapidly in weight. It therefore seems probable that corn and wheat could be much better utilized and a considerable saving in the cost of feeding effected by supplementing these cereals with peanut meal.

Many samples of products obtained during the crushing of peanuts for oil were analyzed. Most of the peanuts used for this purpose were of the Spanish variety; a few mixtures of the Virginia Runner and Spanish were analyzed. The results of the analyses are reported in Tables 1 to 11.

TABLE 1.—*Pure peanut meals and cake from crushing shelled hand-picked peanut meats.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 31243 | 7.5 | 4.0 | 8.6 | 50.6 | 4.7 | 24.6 |
| 31244 | 7.5 | 4.4 | 8.4 | 52.1 | 5.0 | 22.6 |
| 29297 | 6.5 | 4.4 | 8.0 | 52.3 | 4.5 | 24.3 |
| Average | 7.2 | 4.3 | 8.4 | 51.7 | 4.7 | 23.8 |

TABLE 2.—*Products from crushing whole peanuts by the expeller process.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 29252 | 6.1 | 3.9 | 6.5 | 34.4 | 27.1 | 22.0 |
| 29253 | 5.8 | 4.3 | 6.6 | 36.8 | 25.8 | 20.7 |
| 29295 | 6.4 | 3.6 | 7.2 | 34.7 | 26.4 | 21.7 |
| 31281 | 7.2 | 4.1 | 6.4 | 37.7 | 22.2 | 22.4 |
| 31282 | 5.1 | 4.3 | 10.1 | 37.6 | 22.3 | 20.6 |
| 31294 | 6.6 | 3.9 | 7.2 | 38.6 | 21.9 | 21.8 |
| Average | 6.2 | 4.0 | 7.3 | 36.6 | 24.3 | 21.5 |

[4] The proteins of the peanut, *Arachis hypogæa:* II. Distribution of the basic nitrogen in the globulins arachin and conarachin. J. Biol. Chem. (1917), 30: 33–38.

TABLE 3.—*Pure peanut hulls from hand-shelled peanuts.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 31400 | 8.7 | 2.1 | 1.2 | 6.1 | 67.9 | 14.0 |
| 31401 | 8.0 | 3.1 | .8 | 5.7 | 64.5 | 17.9 |
| 31409 | 7.5 | 2.6 | .6 | 5.6 | 65.3 | 18.4 |
| 31249 | 6.7 | 2.2 | 1.6 | 5.8 | 69.7 | 14.0 |
| 31280 | 6.5 | 2.4 | 1.0 | 5.2 | 68.4 | 16.5 |
| 31292 | 8.3 | 2.5 | .8 | 4.4 | 70.0 | 14.0 |
| 31302 | 6.2 | 2.0 | .5 | 5.0 | 69.3 | 17.0 |
| 31304 | 8.3 | 2.5 | 1.6 | 5.9 | 66.3 | 15.4 |
| 31310 | 7.7 | 3.2 | 1.9 | 5.9 | 65.6 | 15.7 |
| 31317 | 6.9 | 2.6 | .6 | 4.6 | 68.9 | 16.4 |
| 31318 | 6.0 | 2.9 | .7 | 5.0 | 68.8 | 16.6 |
| 31328 | 8.6 | 2.7 | .6 | 4.8 | 68.6 | 14.7 |
| 31330 | 7.5 | 2.1 | .9 | 5.5 | 63.5 | 20.5 |
| Average | 7.5 | 2.5 | 1.0 | 5.4 | 67.5 | 16.1 |

TABLE 4.—*Peanut hulls obtained at the mills.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 31255 | 7.1 | 2.4 | 1.4 | 5.6 | 70.0 | 13.5 |
| 31290 | 8.1 | 2.8 | 2.7 | 6.8 | 61.6 | 18.0 |
| 31293 | 8.2 | 4.8 | 2.7 | 6.1 | 64.0 | 14.2 |
| 31301 | 8.6 | 3.7 | 2.2 | 6.3 | 61.4 | 17.8 |
| 31302 | 6.2 | 1.2 | .5 | 5.1 | 69.3 | 17.7 |
| 29262 | 7.8 | 2.9 | 6.5 | 7.2 | 61.2 | 14.4 |
| 29257 | 8.5 | 2.9 | .4 | 4.4 | 69.6 | 14.2 |
| 29225 | 8.3 | 2.6 | .4 | 6.1 | 64.6 | 18.0 |
| 29263 | 7.9 | 1.9 | .5 | 5.0 | 71.3 | 13.4 |
| 29336 | 7.8 | 4.6 | 4.1 | 9.8 | 47.0 | 26.7 |
| 29337 | 7.4 | 3.6 | 3.6 | 9.6 | 50.7 | 25.1 |
| 31245 | 8.1 | 2.1 | 3.3 | 7.5 | 62.3 | 16.7 |
| 31306 | 8.2 | 3.3 | 1.9 | 6.9 | 65.5 | 14.2 |
| 31316 | 8.2 | 4.0 | 9.1 | 10.1 | 51.2 | 17.4 |
| 31319 | 8.6 | 2.7 | 7.8 | 5.6 | 61.0 | 14.3 |
| 31326 | 8.5 | 2.7 | 1.2 | 5.4 | 66.7 | 15.5 |
| 31411 | 6.6 | 2.8 | 2.2 | 8.1 | 62.3 | 18.0 |
| 31801 | 8.6 | 3.7 | 2.2 | 6.3 | 61.4 | 17.8 |
| Average | 7.9 | 3.0 | 2.9 | 6.8 | 62.3 | 17.1 |

TABLE 5.—*High-grade cake and meal made by the hydraulic process from stock from which hulls had been removed by suction.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 29261 | 7.7 | 5.9 | 7.5 | 46.6 | 8.8 | 23.5 |
| 31251 | 6.4 | 7.0 | 8.1 | 45.9 | 10.5 | 22.1 |
| 31252 | 6.3 | 7.3 | 8.0 | 45.3 | 11.1 | 22.0 |
| 31256 | 7.8 | 5.0 | 7.7 | 46.5 | 10.5 | 22.5 |
| 31257 | 7.4 | 5.3 | 9.7 | 47.2 | 8.8 | 21.6 |
| 31288 | 7.4 | 4.0 | 7.1 | 46.3 | 10.2 | 25.0 |
| 31289 | 8.0 | 4.5 | 7.8 | 45.8 | 11.2 | 22.7 |
| 31286 | 6.9 | 4.6 | 10.5 | 48.3 | 8.1 | 21.6 |
| 31307 | 6.7 | 5.1 | 10.2 | 47.1 | 9.5 | 21.4 |
| 31309 | 7.9 | 4.7 | 8.5 | 47.6 | 9.3 | 22.0 |
| 31312 | 6.9 | 5.9 | 8.1 | 49.0 | 7.4 | 22.7 |
| 31314 | 7.1 | 5.3 | 9.4 | 48.0 | 8.5 | 21.7 |
| 31315 | 7.9 | 9.6 | 6.9 | 46.5 | 4.6 | 24.5 |
| 31321 | 7.6 | 5.4 | 8.0 | 45.9 | 10.8 | 22.3 |
| 31327 | 7.9 | 5.5 | 9.8 | 46.9 | 9.2 | 20.7 |
| 31410 | 7.5 | 4.6 | 8.3 | 47.1 | 9.6 | 22.9 |
| Average | 7.3 | 5.6 | 8.5 | 46.9 | 9.5 | 22.4 |

TABLE 6.—*Peanut meals and cake of lower grade with different quantities of hulls left in or ground in after pressing.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 29224 | 7.1 | 4.5 | 8.1 | 39.5 | 19.6 | 21.2 |
| 29226 | 6.8 | 4.5 | 8.4 | 38.6 | 21.2 | 20.5 |
| 29242 | 6.8 | 5.2 | 9.2 | 31.9 | 27.2 | 19.7 |
| 29247 | 6.4 | 4.9 | 7.6 | 38.4 | 19.8 | 22.9 |
| 29248 | 6.8 | 5.5 | 8.2 | 39.5 | 16.7 | 23.3 |
| 29260 | 7.6 | 5.6 | 6.4 | 40.9 | 14.2 | 25.3 |
| 29339 | 7.3 | 8.1 | 8.7 | 38.8 | 16.0 | 21.1 |
| 31238 | 7.8 | 4.3 | 8.8 | 43.3 | 11.7 | 24.1 |
| 31242 | 8.5 | 3.2 | 5.5 | 28.4 | 34.9 | 19.5 |
| 31291 | 8.0 | 4.4 | 6.8 | 43.8 | 15.2 | 21.8 |
| 31300 | 7.4 | 3.7 | 11.4 | 34.4 | 21.5 | 21.6 |
| 31303 | 7.5 | 3.8 | 10.9 | 34.8 | 26.5 | 16.5 |
| 31311 | 7.2 | 5.8 | 7.0 | 36.7 | 24.0 | 19.3 |
| 31325 | 7.8 | 4.3 | 8.8 | 44.4 | 12.9 | 21.8 |
| 31399 | 8.3 | 2.7 | 8.8 | 43.4 | 12.1 | 24.7 |

TABLE 7.—*Peanut stock from which the hulls had been removed by suction on the way to the crushers.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. | Hulls not removed.[1] |
|---|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 31250 | 4.4 | 2.8 | 45.7 | 28.7 | 3.5 | 14.9 | 2.0 |
| 31287 | 4.0 | 2.7 | 40.1 | 28.8 | 10.6 | 13.8 | [2] 12.0 |
| 31294 | 6.9 | 2.8 | 46.1 | 29.8 | 3.5 | 10.9 | 2.5 |
| 31308 | 4.6 | 3.0 | 42.8 | 28.2 | 8.4 | 13.0 | 5.0 |
| 31313 | 5.3 | 2.4 | 48.0 | 27.6 | 4.0 | 12.7 | 3.5 |
| 31320 | 4.3 | 2.6 | 48.1 | 29.1 | 2.8 | 13.1 | 1.0 |
| 31324 | 5.0 | 2.5 | 47.9 | 30.2 | 2.6 | 11.8 | 1.0 |
| 31331 | 4.5 | 2.5 | 46.8 | 29.6 | 3.6 | 13.0 | 2.5 |

[1] Approximate. [2] Miller stated that this was not a good separation and was not normal.

TABLE 8.—*Proportion of meats to hulls and of "pops" to normal peanuts.*

| Sample No. | Variety. | Hulls. | Meats. | "Pops." |
|---|---|---|---|---|
| | | *Per cent.* | *Per cent.* | *Per cent.* |
| 29230 | Mostly Spanish | 25.0 | 75.0 | 2.2 |
| 29236 | do | 24.0 | 76.0 | 1.3 |
| 29238 | Spanish and Virginia Runner. | 26.0 | 74.0 | 6.3 |
| 29245 | Mostly Virginia Runner | 29.4 | 70.6 | 7.2 |
| 29254 | Spanish and Virginia Runner. | 25.5 | 74.5 | 2.5 |
| 29255 | do | 25.3 | 74.7 | 3.0 |
| 29293 | Mostly Virginia Runner | 29.0 | 71.0 | 6.3 |
| 29296 | Spanish | 24.0 | 76.0 | 4.0 |
| 29335 | Virginia Runner | 29.8 | 70.2 | 5.0 |
| 31248 | Spanish | 21.0 | 79.0 | .0 |
| 31249 | do | 23.4 | 76.6 | 2.4 |
| 31280 | do | 22.5 | 77.5 | 3.0 |
| 31283 | do | 21.7 | 78.3 | .6 |
| 31292 | do | 23.1 | 76.9 | 1.2 |
| 31302 | do | 23.2 | 76.8 | 8.4 |
| 31304 | do | 21.0 | 79.0 | 3.8 |
| 31310 | do | 23.5 | 76.5 | 4.6 |
| 31317 | do | 22.0 | 78.0 | 5.0 |
| 31318 | do | 23.0 | 77.0 | .0 |
| 31323 | do | 22.0 | 78.0 | 2.4 |
| 31328 | Spanish and Virginia Runner. | 23.7 | 76.3 | 4.5 |
| 31402 | Virginia Runner | 27.7 | 72.3 | 10.0 |
| 31405 | do | 29.0 | 71.0 | 2.2 |
| 38409 | Spanish and Virginia Runner. | 24.9 | 75.1 | 6.8 |
| Av. | | 24.5 | 75.5 | ..... |

TABLE 9.—*Peanut skins ("red skins" or the coverings of peanut meats).*

| Sample No. | Taken from— | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|---|
| | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 29634 | Peanut-butter plant, Virginia variety. | 6.6 | 4.2 | 28.6 | 21.1 | 9.1 | 30.4 |
| 29145 | Peanut-butter plant, Spanish variety. | 3.1 | 2.8 | 28.4 | 16.1 | 11.8 | 37.8 |
| 31228 | Confectioners' plant, Virginia variety. | 7.3 | 3.4 | 30.1 | 18.1 | 11.4 | 29.7 |
| 31229 | Peanut-butter plant, Spanish variety. | 9.1 | 2.5 | 31.2 | 16.5 | 10.3 | 30.4 |
| 31248 | Peanut skins removed by hand, Spanish variety. | 9.3 | 3.0 | 4.5 | 12.7 | 11.2 | 59.3 |

TABLE 10.—*Peanut germs ("peanut hearts").*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 31232... | 4.5 | 2.9 | 45.5 | 28.8 | 6.0 | 12.3 |
| 31236... | 6.7 | 3.3 | 45.8 | 29.5 | 3.0 | 11.7 |
| Av. | 5.6 | 3.1 | 45.4 | 29.1 | 4.5 | 12.0 |

TABLE 11.—*Peanut meats.*

| Sample No. | Moisture. | Ash. | Ether extract. | Protein. | Fiber. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 29254..... | 4.3 | 2.3 | 48.0 | 27.8 | 2.6 | 15.0 |
| 29335..... | 4.4 | 2.4 | 48.2 | 32.2 | 2.3 | 10.5 |
| 31401..... | 4.3 | 2.3 | 47.8 | 29.8 | 2.8 | 13.0 |
| 31409..... | 5.0 | 2.2 | 47.1 | 31.4 | 2.3 | 12.0 |
| 31239..... | 4.4 | 2.4 | 50.4 | 28.5 | 3.7 | 10.6 |
| 31246..... | 5.4 | 2.5 | 47.6 | 30.0 | 2.7 | 11.8 |
| 31249..... | 5.6 | 2.6 | 45.6 | 29.6 | 3.2 | 13.4 |
| 31250..... | 4.4 | 2.8 | 45.7 | 28.7 | 3.3 | 15.1 |
| 31253..... | 4.9 | 2.6 | 45.5 | 29.9 | 2.6 | 14.5 |
| 31383..... | 5.2 | 2.4 | 47.6 | 30.4 | 2.9 | 11.5 |
| 31297..... | 5.4 | 2.3 | 46.1 | 30.6 | 3.1 | 12.5 |
| 31280..... | 5.2 | 2.6 | 46.1 | 30.6 | 2.4 | 13.1 |
| 31302..... | 4.4 | 2.4 | 48.2 | 29.1 | 2.6 | 13.3 |
| 31304..... | 5.2 | 2.1 | 48.4 | 29.5 | 2.4 | 12.4 |
| 31310..... | 4.4 | 2.5 | 47.9 | 28.9 | 2.5 | 13.8 |
| 31317..... | 5.1 | 2.5 | 46.0 | 29.5 | 3.2 | 13.7 |
| 31318..... | 4.5 | 2.5 | 47.5 | 29.5 | 2.8 | 13.2 |
| 31405..... | 4.5 | 2.7 | 46.7 | 28.6 | 3.1 | 14.4 |
| 31328..... | 4.5 | 2.4 | 47.1 | 31.1 | 2.8 | 12.1 |
| Average.. | 4.8 | 2.4 | 47.2 | 29.8 | 2.8 | 12.9 |

The ether-extract determination for the sample of skins removed by hand from the unheated peanuts is noticeably different from that for samples obtained from peanut-butter plants and confectioners' establishments. On this sample the proportion of skins to meats was approximately 2.5 per cent. Sample 29145 contained 0.3 per cent of invert sugars and 2.4 per cent of nonreducing sugars.

The peanut germs analyzed (Table 10) were obtained at peanut-butter plants and confectioners' establishments. They are bitter,

and the fat which they contain breaks up rapidly, becoming rancid, making it necessary to remove them to secure a good product.

The peanut meats analyzed (Table 11) were shelled by hand from peanuts obtained at the warehouse. Sugar and starch determinations were made on one sample of Spanish variety peanuts, with the following results:

| | Per cent. |
|---|---|
| Reducing sugars as invert sugars | 0.3 |
| Nonreducing sugars as sucrose | 4.7 |
| Starch | 4.7 |
| Total sugars and starch | 9.7 |

## DEFINITIONS OF PEANUT PRODUCTS.

The Association of the Feed Control Officials of the United States have adopted the following definitions for peanut products:

*Peanut-oil cake* is the residue after extraction of part of the oil by pressure or solvents from peanut kernels.

*Peanut-oil meal* is ground peanut-oil cake.

*Unhulled peanut-oil feed* is the ground residue obtained after extraction of part of the oil from whole peanuts, and the ingredients shall be designated as "peanut meal and hulls."

Peanut-oil meal, being the residue after extracting part of the oil from the peanut kernels, should contain no hulls. A product containing a mixture of meal and hulls should be designated as such a mixture. It is impossible, however, even in the most efficiently run mills, to remove all the hulls by shakers and suction, which is the usual commercial practice. A certain amount of hulls remains in the stock as it goes to the crushers and a much larger amount in the resulting meal. For instance, if the oil content of the stock is 48 per cent and the oil content of the meal is 7 per cent the meal will have 1.8 times as much hulls as the stock which goes to the crushers. Under the present milling conditions, therefore, it is necessary to permit the presence of a certain amount of hulls in a meal in order that the definition may be practical. It follows that a method for determining the percentage of hulls in a meal will be necessary for control work.

A study of Tables 1 and 3 suggests two possibilities for methods for determining the amount of hulls in mixtures of meal and hulls, one based upon the crude-fiber content and the other upon the protein content. The average fiber content of hulls is 67.5 per cent and the average fiber content of pure meal is 4.7 per cent. The average protein content of hulls is 5.4 per cent and the average protein content of pure meal is 51.7 per cent, based on a moisture content of about 7 per cent.

For the purpose of determining hulls from the fiber content and from the protein content in mixtures of meal and hulls the following formulas have been developed:

FORMULA 1.

$$\text{Let } X = \text{the hulls}$$
$$\text{Then } 100 - X = \text{the meal}$$
$$0.675X + 0.047\,(100 - X) = \text{fiber}$$
$$0.628X + 4.7 = \text{fiber}$$
$$X = \frac{\text{fiber} - 4.7}{0.628}$$

FORMULA 2.

$$\text{Let } X = \text{hulls}$$
$$\text{Then } 100 - X = \text{meal}$$
$$0.054X + 0.517\,(100 - X) = \text{protein}$$
$$0.054X + 51.7 - 0.517X = \text{protein}$$
$$-0.463X = \text{protein} - 51.7$$
$$X = \frac{51.7 - \text{protein}}{0.463}$$

TABLE 12.—*Basis for calculating hull content of mixtures of hulls and meal from fiber and protein content.*

| Hulls. | Fiber. | Protein. | Hulls. | Fiber. | Protein. | Hulls. | Fiber. | Protein. | Hulls. | Fiber. | Protein. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* |
| 0 | 4.7 | 51.7 | 26 | 21.0 | 39.7 | 52 | 37.4 | 27.6 | 78 | 53.7 | 15.6 |
| 1 | 5.3 | 51.2 | 27 | 21.7 | 39.2 | 53 | 38.0 | 27.2 | 79 | 54.3 | 15.1 |
| 2 | 6.0 | 50.8 | 28 | 22.3 | 38.7 | 54 | 38.6 | 26.7 | 80 | 54.9 | 14.7 |
| 3 | 6.6 | 50.3 | 29 | 22.9 | 38.3 | 55 | 39.2 | 26.2 | 81 | 55.6 | 14.2 |
| 4 | 7.2 | 49.8 | 30 | 23.5 | 37.8 | 56 | 39.9 | 25.8 | 82 | 56.2 | 13.7 |
| 5 | 7.8 | 49.4 | 31 | 24.2 | 37.3 | 57 | 40.5 | 25.3 | 83 | 56.8 | 13.3 |
| 6 | 8.5 | 48.9 | 32 | 24.8 | 36.9 | 58 | 41.1 | 24.8 | 84 | 57.4 | 12.8 |
| 7 | 9.1 | 48.5 | 33 | 25.4 | 36.4 | 59 | 41.8 | 24.4 | 85 | 58.0 | 12.3 |
| 8 | 9.7 | 48.0 | 34 | 26.0 | 36.0 | 60 | 42.4 | 23.9 | 86 | 58.7 | 11.9 |
| 9 | 10.3 | 47.5 | 35 | 26.7 | 35.5 | 61 | 43.0 | 23.5 | 87 | 59.3 | 11.4 |
| 10 | 11.0 | 47.1 | 36 | 27.3 | 35.0 | 62 | 43.6 | 23.0 | 88 | 60.0 | 11.0 |
| 11 | 11.6 | 46.6 | 37 | 27.9 | 34.6 | 63 | 44.3 | 22.5 | 89 | 60.6 | 10.5 |
| 12 | 12.2 | 46.1 | 38 | 28.6 | 34.1 | 64 | 44.9 | 22.1 | 90 | 61.2 | 10.0 |
| 13 | 12.9 | 45.7 | 39 | 29.2 | 33.6 | 65 | 45.5 | 21.6 | 91 | 61.8 | 9.6 |
| 14 | 13.5 | 45.2 | 40 | 29.8 | 33.2 | 66 | 46.1 | 21.1 | 92 | 62.5 | 9.1 |
| 15 | 14.1 | 44.8 | 41 | 30.4 | 32.7 | 67 | 46.8 | 20.7 | 93 | 63.1 | 8.6 |
| 16 | 14.7 | 44.3 | 42 | 31.1 | 32.3 | 68 | 47.4 | 20.2 | 94 | 63.7 | 8.2 |
| 17 | 15.4 | 43.8 | 43 | 31.7 | 31.8 | 69 | 48.0 | 19.8 | 95 | 64.4 | 7.7 |
| 18 | 16.0 | 43.4 | 44 | 32.3 | 31.3 | 70 | 48.7 | 19.3 | 96 | 65.0 | 7.3 |
| 19 | 16.6 | 42.9 | 45 | 33.0 | 30.9 | 71 | 49.2 | 18.8 | 97 | 65.6 | 6.8 |
| 20 | 17.3 | 42.4 | 46 | 33.6 | 30.4 | 72 | 49.9 | 18.4 | 98 | 66.2 | 6.3 |
| 21 | 17.9 | 42.0 | 47 | 34.2 | 29.9 | 73 | 50.5 | 17.9 | 99 | 66.9 | 5.9 |
| 22 | 18.5 | 41.5 | 48 | 34.8 | 29.5 | 74 | 51.1 | 17.4 | 100 | 67.5 | 5.4 |
| 23 | 19.1 | 41.1 | 49 | 35.5 | 29.0 | 75 | 51.8 | 17.0 | | | |
| 24 | 19.8 | 40.6 | 50 | 36.1 | 28.6 | 76 | 52.4 | 16.5 | | | |
| 25 | 20.4 | 40.1 | 51 | 36.7 | 28.1 | 77 | 53.0 | 16.0 | | | |

From the figures given in Table 12, obtained by applying these formulas, it is possible to determine the hull content of a mixture of meal and hulls from the fiber content or the protein content. These determinations can be only approximations, since the fiber in hulls and the protein in the meats vary somewhat. They are accurate enough, however, to be of value in control work and are the only measuring sticks for hulls known at present. The methods are not sufficiently accurate to make it worth while to reduce the products to an equal oil basis, as the oil in the meals does not vary

enough to make any material difference. Similar methods of calculation have been suggested in Texas Agricultural Experiment Station Bulletin 22, "The Composition of Peanuts and Peanut By-products." The method based on the fiber content will probably be more accurate

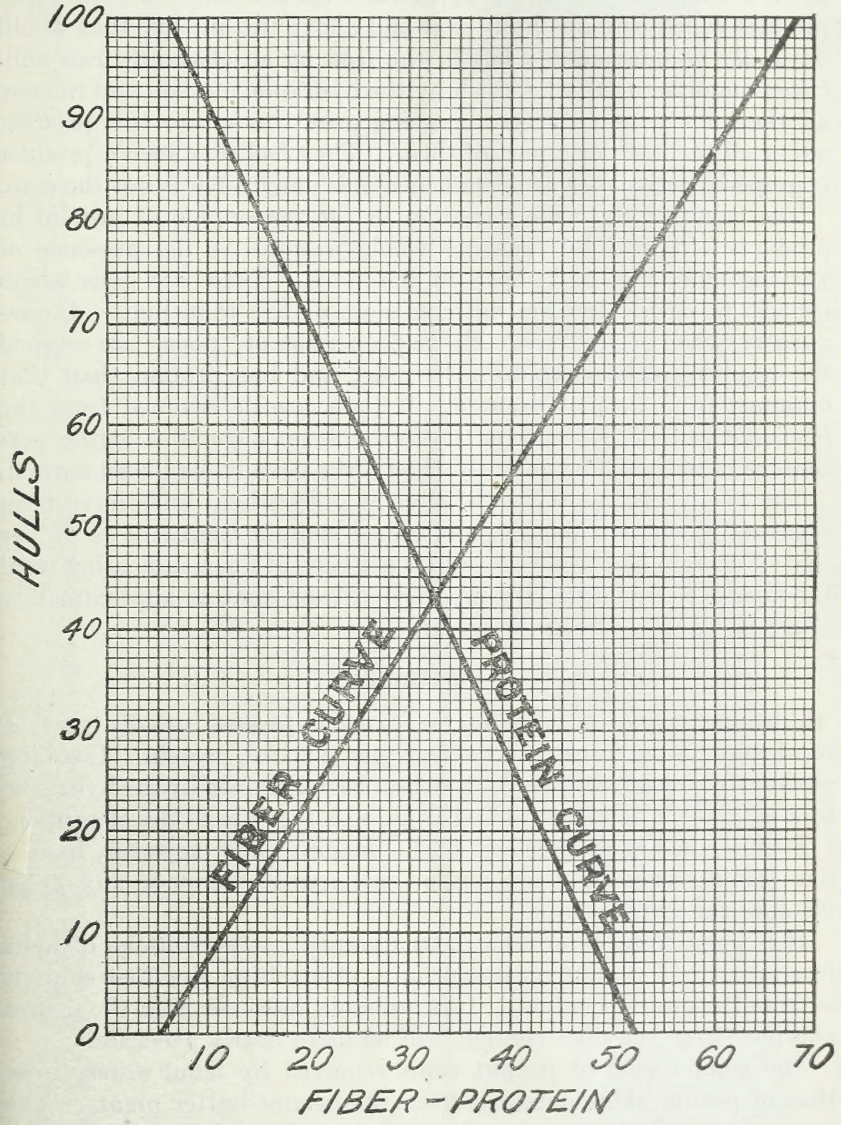


FIG. 1.—Relation of fiber content and protein content to hulls.

than the one based on the protein content, since hulls consist largely of fiber. From the curves in Figure 1 hulls can be determined at a glance from either the fiber content or the protein content.

The crushing of whole peanuts is usually done by the expeller process. The results in Table 2 indicate that a product containing from 34.4 to 38.6 per cent of protein is obtained. There seems to be a tendency in the industry to consider this product as peanut meal, although it is not, but is peanut meal and hulls, as is also any product which contains hulls over and above the amount that would naturally be unavoidably left in the feed by an efficiently run mill. Often manufacturers who crush by the hydraulic method and remove all the hulls possible before crushing grind back into this product either all the hulls or a part of them. They feel that such a product is properly designated as peanut meal, although such is not the case.

The cause of the wide variation in the percentage of protein in products obtained by crushing whole peanuts is the presence of varying quantities of "pops" in the stock. These are pods which contain no meats and are nothing more or less than hulls. Consequently, when peanuts with a large proportion of "pops" are crushed the resulting cake contains more fiber and less protein than that obtained from normal peanuts. If hulls are determined from the fiber and protein content by the formulas on page 10 a higher percentage of hulls will be obtained than if the peanuts had been normal.

The results in Table 5 show that in mills where hulls have been removed by suction the meals obtained contain from 45.3 to 49 per cent of protein and from 4.6 to 11.2 per cent of fiber, indicating from the fiber determinations the presence of from none to approximately 10.3 per cent of hulls in the meals.

## SUMMARY.

Crushing whole peanuts by the expeller process usually gives a meal containing from 34.4 to 38.6 per cent of protein. Crushing peanuts from which the hulls have first been removed by the hydraulic process gives a meal containing from 45.3 to 49 per cent of protein.

Peanut meal is an excellent feed. Peanut hulls, however, have a low feeding value and can not be economically shipped any great distance for use as a feed.

It is possible to determine approximately the percentage of hulls in a mixture of peanut meal and hulls, either from the fiber content or from the protein content. It is probable, however, that the figures obtained from the fiber content will be more nearly accurate.

The composition of peanut skins removed by hand differs from that of peanut skins obtained from the peanut-butter plants. The composition of peanut germs is similar to that of the meats, with somewhat lower oil and somewhat higher ash contents.

A sample of meats from the Spanish variety of peanuts was found to contain 5 per cent of sugars and 4.7 per cent of starch.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1922